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Dated 24 February 1999

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Request for Grant of a Patent

The Patent Office
Cardiff Road
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1. Your reference — ACW/P78589 GB

2. Patent Application number *(the Patent Office will fill in this part)* — 9802388.0 — 4 FEB 1998

3. Full name, address and postcode of the or of each Applicant *(underline all surnames)*

TODD, John James,
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Patents ADP Number *(if you know it)* 7372907001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the Invention — WASTE WATER TREATMENT, MEDIA THEREFOR AND ITS MANUFACTURE

5. Name of your Agent *(if you have one)* — URQUHART-DYKES & LORD

"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

91 Wimpole Street,
London,
W1M 8AH,
Great Britain.

Patents ADP Number *(if you know it)* — 1644002

6. If you are declaring priority from one or more earlier Patent Applications, give the country and the date of filing of the or of each of these earlier Applications and *(if you know it)* the or each Application Number

Country	*Priority application No. (if you know it)*	*Date of Filing (Day/month/year)*

7. If this Application is divided or otherwise derived from an earlier UK Application, give the Number and the Filing Date of the earlier Application

Number of earlier application	*Date of Filing (Day/month/year)*

8. Is a Statement of Inventorship and of Right to Grant of a Patent required in support of this request ? *(Answer 'Yes' if:*

YES

a) any Applicant named in part 3 is not an inventor, or
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Continuation sheet of this Form	0
Description	9
Claim(s)	0
Abstract	0
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Priority documents	0
Translations of priority documents	0
Statement of Inventorship and Right to Grant a Patent *(Patents Form 7/77)*	1
Request for Preliminary Examination *(Patents Form 9/77)*	0
Request for Substantive Examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	

11. I/We request the grant of a Patent on the basis of this Application

Signature Date 4 February 1998

URQUHART-DYKES & LORD

12. Name and daytime telephone number of person to contact in the United Kingdom

A.C. Wood - 0171 629 1771

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WASTE WATER TREATMENT, MEDIA THEREFOR AND ITS MANUFACTURE

This invention relates to loose particulate material for use in waste water treatment plant and methods, to the manufacture of such material, and to methods and apparatus for the treatment of waste water using such material.

Waste water may be treated by gasification, for example by the aeration or oxygenation of sewage or other waste water containing organic matter degradable by the action of oxygen thereon. A wide range of treatment methods and apparatus has been used and proposed. Oxygen does not dissolve easily or quickly in water and it is therefore in principle desirable to utilize fine bubble aerators wherein the bubbles are less than 2 mm and desirably less than 1 mm in diameter. Smaller bubbles have a larger specific surface area for oxygen transfer into the liquid, and also rise more slowly through the liquid to give a longer time for the oxygen to transfer before the bubble reaches the liquids surface. Treatment plants are known comprising a treatment vessel with aerator devices submerged in the waste water to produce the bubbles.

It has also been proposed to provide a treatment plant where the treatment vessel contains a bed of loose material. Aeration then causes a degree of fluidization of the bed and sustains the growth of a population of microorganisms on the material of the bed. In the presence of dissolved oxygen the microorganisms convert the organic matter in the waste water to carbon dioxide, water and to more bulky cellular materials and sludge thus alleviating the biological oxygen demand (BOD). Under appropriate operating conditions they will also convert ammonia to nitrate compounds. The surplus sludge thus formed can pass out with the effluent for eventual separation and recycling if desired.

Problems of fouling and clogging of the aerator devices and any pipe work can be acute where they are buried or caged beneath a bed of loose material. Regular closing and draining of the plant for cleaning and unblocking or replacement of the aerators is inefficient and expensive due to the need also to move aside or remove the filter bed material to gain access to the buried aerators.

Our publication no. WO/95/17351 describes a method and apparatus for treatment of waste water wherein such problems are mitigated, and in particular discloses loose particulate material for use as a fluidizable bed in the waste water treatment, said material being characterized by particles of a substantially inert mineral adhered to, coated on or coated by plastics material to provide a habitat for microorganisms effective in waste water treatment.

That Publication discloses such loose particulate material having a density in the range of from substantially 1.0 to substantially 1.3 g/cc, having a specific surface area in excess of approximately 600 m^2 per cubic metre of the loose material, and having a particle size range of substantially 3 mm to substantially 10 mm in diameter. An example of the material is disclosed as particles of sand or other inert mineral particles at least partially adhered to, coated on or coated by plastics material, preferably a thermoplastics material such as polyethylene. It was disclosed that the material could be produced to a desired density for a particular application by changing the initial proportions of mineral and plastics.

Our Publication No. WO/96/25367 describes improved loose particulate material for use in waste water treatment. It discloses granules of plastics material having grains of an inert mineral such as sand coated thereon, the granules having a predetermined particle size

range, and the grains having a predetermined particle size range and being disposed at a predetermined packing density range on the granules. The particles have an average density of approximately 1.0 g/cc such that a proportion tends to float and a proportion tends to sink in the waste water. The particles are manufactured by contacting the granules of plastics material with a mixture of grains of the inert mineral and grains of a soluble substance such as salt, at an elevated temperature, to coat the granules with the mixture, and subsequently dissolving the soluble substance grains from the coating to provide the granules coated with the grains of inert mineral in the predetermined packing density range.

Such loose particulate material has been found in practice to be effective for use in waste water treatment. Such materials have been found to provide a particularly suitable habitat for a high population density of microorganisms of the type effective in waste water treatment.

The inventors have also found that, by using significantly embedded grains, the subsequent step of dissolving away the soluble substance grains leaves concavities in the surface of the granules thereby aiding achievement of the desired high specific surface area.

An object of the present invention is to provide further improved material for waste water treatment and methods for its manufacture.

According to the present invention in one aspect there is provided loose particulate material for use in waste water treatment, said material characterised by granules of plastics material carrying weighting material so that the particles have an average density of approximately 1.0 g/cc, at least a proportion of said weighting material being carried within the granules, and the surface of the granules being provided with

concavities to provide a habitat for microorganisms effective in waste water treatment.

The weighting material, i.e. filler, may be grains of sand, salt, lime, chalk or other substantially inert mineral.

The weighting material is preferably incorporated substantially wholly within the granules such that the weighting material is substantially not exposed at the surface of the granules.

An advantage of incorporating the grains of weighting material largely or wholly within the granules is that the grains can achieve the required weighting function to bring the average particle density to approximately 1.0 g/cc and reducing their likelihood of becoming gradually abraded away over an extended period of use. It is desirable for waste water treatment plants to function for periods of many years between major refits.

If the sand grains are largely exposed on the surface of the granules, as with the particles described in our above-mentioned WO/96/25367, they may become abraded away over a period of use. The proportion of granules of lower density than aerated waste water would then be undesirably increased.

However, the invention includes particles wherein the granules have both weighting material incorporated wholly within the granules and also a surface coating of grains. The weighting material and the surface grains may both be grains of sand or other substantially inert mineral. The surface grains provide convexities thus cooperating with the concavities to increase the specific surface area and thus to increase the habitat area for the microorganisms. A further advantage of providing some surface grains is that they can effectively prevent the granules from adhering to one another, during manufacture or use, in undesirable agglomerations.

The present invention also provides a method of manufacture of loose particulate material for use in waste water treatment, said method comprising incorporating a weighting material within granules of plastics material so that at least a proportion of the weighting material is carried within the granules and the particles have an average density of approximately 1.0 g/cc, and contacting the granules with grains of a soluble substance, at an elevated temperature, to coat the granules with the soluble substance grains, and subsequently dissolving the soluble substance grains from the coating to provide the surface of the granules with concavities to serve as a habitat for microorganisms effective in waste water treatment.

The grains of a soluble substance can conveniently be salt grains.

The granules are preferably contacted with the soluble substance grains at an elevated temperature such that the grains coat the granules by burying themselves significantly into a partially melted outer surface of the granules, whereby the step of dissolving the soluble substance grains leaves the desired concavities in the granules surface.

In another aspect the present invention provides a waste water treatment medium characterised by a plastics material substrate having a surface provided with concavities to provide a habitat for microorganisms effective in waste water treatment.

The medium may be a structure adapted to be fixed in position within a waste water treatment vessel.

In yet a further aspect, the present invention provides a method of manufacture of a waste water treatment medium comprising contacting a plastics material substrate with grains of a soluble substance, at an elevated temperature, to coat the substrate with the soluble substance grains, and subsequently dissolving the

soluble substance grains from the coating to provide the surface of the substrate with concavities to serve as a habitat for microorganisms effective in waste water treatment.

An embodiment of the invention will now be described.

Granules of plastics material are provided. These are suitably granules of polyethylene and preferably have substantially uniform particle size. The particle size is suitably in the range 3 to 10 mm considered as a sieve size range. The preferred size range is 4 to 8 mm, preferably about 6 mm. The granules may be of approximately spherical, ellipsoidal or cylindrical shape, or may be of irregular shape such as commercially available recycled chips, for example granulated from moulded rejects. Flattened shapes have a greater specific surface area.

It is desired to achieve a high specific surface area for the loose particulate material, for example in excess of about 600 m^2 per cubic metre or even 2000 m^2 per cubic metre. The greater the specific surface area, the correspondingly larger is the habitat area for the microorganisms effective in the treatment.

The specific gravity of the plastics material is fixed by the choice of plastics material, suitably polyethylene, and is less than 1.0 g/cc. The granules carry weighting materials so that the particles have an average density of approximately 1.0 g/cc. Thus in use a proportion of particles tend to float and a proportion tend to sink in the waste water, but on average have neutral buoyancy so as to circulate easily as the waste water is aerated and circulated. The density is preferably a little less than 1.0 g/cc because aerated waste water itself has a density a little less than 1.0 g/cc.

The weighting material is suitably grains of sand and is preferably incorporated substantially wholly within the

granules. However the invention includes embodiments wherein the granules have sand grains incorporated wholly within the granules and also a surface coating of sand grains. The specific gravity of the mineral, e.g. sharp sand, is substantially greater than 1.0 g/cc and thus the relative quantity of said grains to be incorporated in the granules is determined by the specific gravity of the plastics material to bring the resultant particles up to the desired density of approximately 1.0 g/cc.

The surface of the weighted granules is provided with concavities to serve as habitats for microorganisms effective in waste water treatment. The concavities preferably cover substantially the whole surface of the granules, thereby providing the greatest possible increase in effective surface area.

The concavities may be about 0.1 mm to 1 mm in effective width and in effective depth, preferably about 0.3 mm in width and a little less in depth. It will be appreciated that if such concavities cover substantially the whole surface of the granules then the specific surface area is increased by a factor of about 3 or more, also depending upon the general shape and regularity of the concavities themselves.

The concavities not only increase the specific surface area, and thus the available habitat area for the microorganisms, but they also provide a sheltered environment which particularly favours the growth of a desirably dense and stable population of microorganisms. In prior art arrangements with microorganisms exposed on the external surfaces of media or structures, they are liable to become detached by abrasion or tumbling during circulation of waste water.

A particular advantage of the particles of the present invention is that they are loose and of neutral buoyancy, and are thus continually mobile within and throughout the body of waste water within the treatment

vessel. Thus, during circulation and aeration this ensures high efficiency of contact between the microorganisms and the waste water being treated.

However, an advantage of the invention can also be achieved in relation to other waste water treatment media, for example structures adapted to be fixed in position within a waste water treatment vessel. Such medium is also preferably a plastics material and has a surface similarly provided with said concavities to provide a habitat for microorganisms effective in waste water treatment.

The loose particulate material is suitably manufactured by incorporating the weighting material within the plastics material granules and then creating the surface concavities. The weighted granules are contacted with grains of a soluble substance, at an elevated temperature, to coat the weighted granules with the soluble substance grains, and subsequently dissolving the soluble substance grains from the coating to provide the surface of the granules with the concavities.

The soluble substance may be common salt, i.e. sodium chloride. The salt grain size range is of course governed by the desired size of the eventual concavities and is suitably about 0.3 mm. Salt grains tend to be cubic crystals and thus the eventual concavities also tend to be generally cubic. This is advantageous in increasing the specific surface area.

The soluble substance may however be any economically available granular substance which is soluble in a common solvent, such as water, that does not affect the plastics material and provided that it has a melting point higher than the softening point of the polyethylene granules, i.e. higher than about 200°C.

The weighting material may be identical to the soluble substance. For example, both may be common salt grains. The salt grains incorporated within the granules

as weighting material would thereby tend to be protected from being dissolved away by the waste water.

It has been found possible to provide loose particulate material having a specific surface area considerably in excess of 600 m^2 per cubic metre, i.e. up to 3000 m^2 per cubic metre or 4000 m^2 per cubic metre. Moreover, the concavities provide a sheltered environment which particularly favours the growth of a desirably dense and stable population of microorganisms. The material finds use in waste water treatment plants and methods for example as described in our above-mentioned WO/95/17351 or WO/96/25367.

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Urquhart Dykes & Lord

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